Space Weather Technical Forecast

Issued on Tuesday, 01 March 2022 at 12:40 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

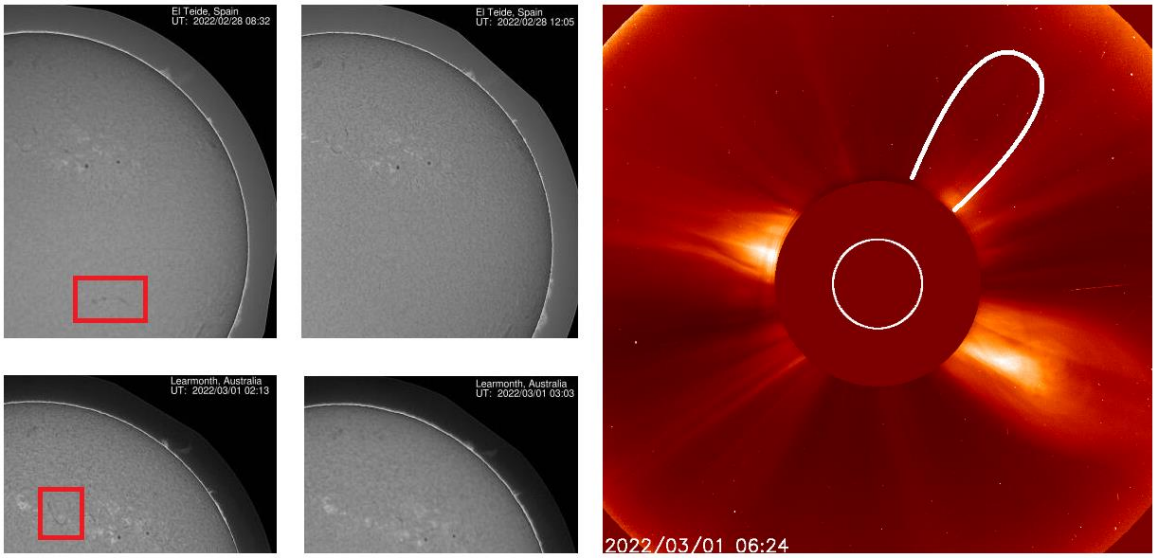
Space Weather Forecast Headline: Chance of G1 Minor Geomagnetic Storms to end current working week. Probable increasing Slight Chance of R1 Minor Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Very Low in the last 24 hours, with no notable X-ray flares recorded at GOES 16. There are currently five numbered sunspot regions on the visible disc. Those in the western solar hemisphere, AR2954 and AR2955 are mature, stable and unipolar Hsx groups. The eastern solar hemisphere was the preserve of three minor and diffuse bipolar groups, with the start of period characterised by overall emergence and proliferation (in AR2956 and 2957 especially), later changing to a stabilising and spreading trend. All of these sunspots displayed rudimentary penumbra and took the form of Zurich Dro/Cri groups.

Some peripheral Coronal Mass Ejections (CMEs) were visible in coronagraphs in the period, with no suggestions of Earth-bound components from analysis. A possible filament lift off from the southwestern quadrant visible into the very start of the past 24 hours (around 28/1130UTC) on El Teide H-Alpha imagery does not appear to obviously tie to either of the main observed CMEs in the period, and this may have been reabsorbed. A second filament lift-off event near the meridian in the northern hemisphere at 01/0230UTC (seen in Learmonth H-Alpha) may be connected to a narrow CME seen heading north of the ecliptic in subsequent coronagraph imagery, to no presumed effect at Earth.

Figure 0: H-Alpha imagery of up to two disappearing filaments in the period. Only the second has been tentatively assigned to any coronagraph ejecta at present, and this is well off the eclpitic plane.



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Solar Wind / Geomagnetic Activity: Earth is currently in an elevated positive polarity fast solar wind, potentially that from CH58 or perhaps CH60. The solar wind speed, as measured by DSCOVR at L1, fluctuated slightly about 500km/s, peaking near 540km/s, with a nadir around 470. The solar wind density was within normal background, running in high single-figures ppcc. The IMF showed a slow rise and fall, peaking at 7nT with the north-south component ranging between +6 and -5nT. The phi angle was variable within a positive sector (away from the sun).

The net result of the above solar wind measures was provisionally Quiet throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2 MeV) has been at Normal Background levels. The corresponding 24-hour integrated electron fluence was well below the Active (1e8 integrated pfu) threshold with a declining trend. The 01/0001 UTC observation was 1.76e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, with isolated C-class flares Likely and a Slight Chance of M-class flares. This may increase slightly in the coming days given possible large returning regions from midweek.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. A series of coronal hole high speed streams should feature in this period - mainly minor and positive polarity up to midweek leading to a Slight Chance of Active. A larger negative polarity hole is due on day four, giving the greatest Chance of G1 on Friday 04 March.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux is likely to follow an erratic rising trend, with the possibility of exceeding the high (1e3 pfu) threshold during diurnal peaks. Electron fluence is also forecast to follow an erratic rising trend, and may approach the Active (1e8 integrated pfu) threshold later in the forecast period.

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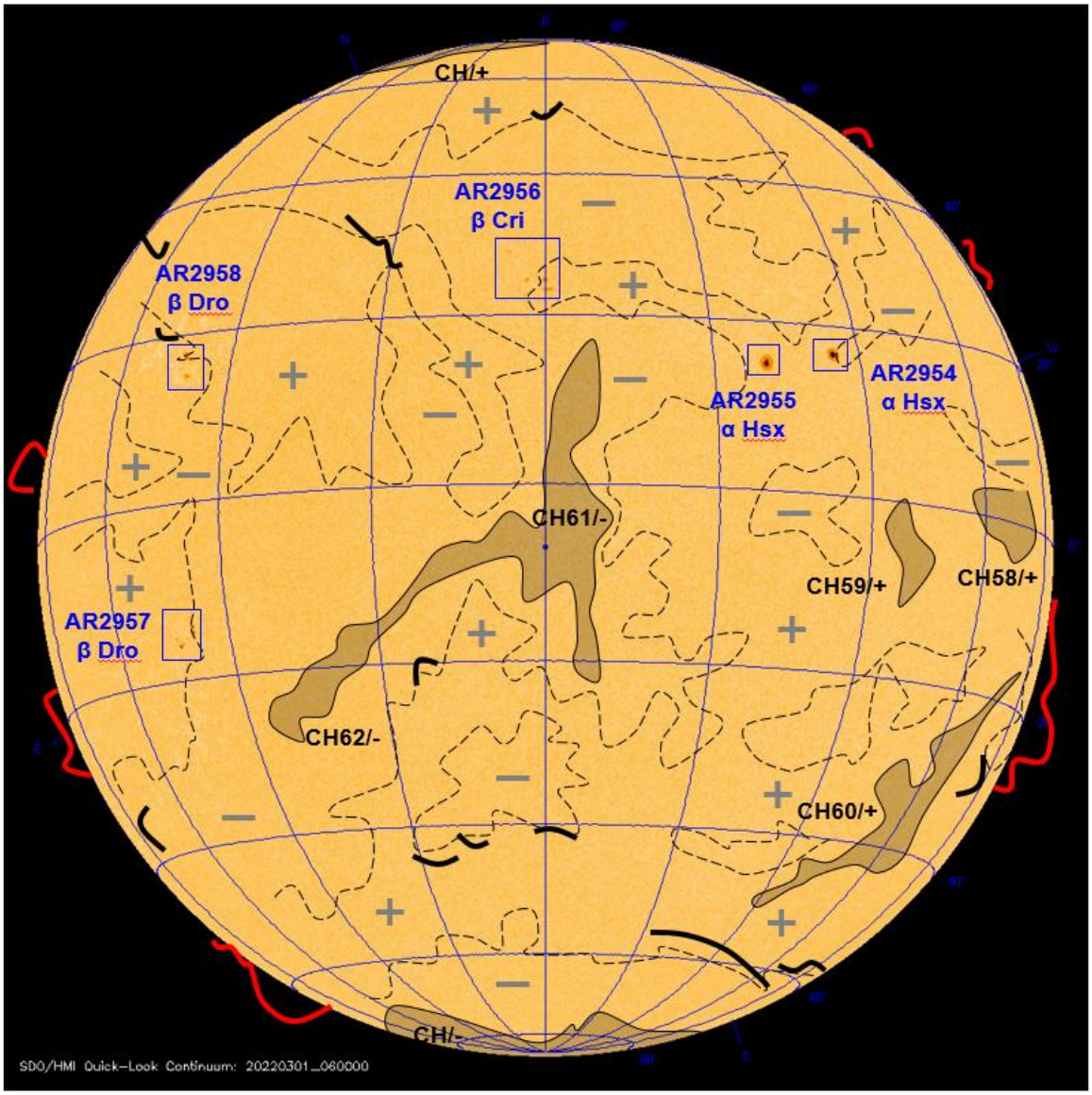
Figure 1. Solar Analysis Valid 01/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs that feature in the forecast.

Solar wind speeds are currently at elevated levels following a connection with the high speed stream from either coronal hole 58 or 60. A further connection with coronal hole 59 is then probable on day 1 (01 March), with elevated wind speeds likely lasting into day 2 (02 March) before slowly easing. It is probable that the effects will merge, making it difficult to tell the individual features apart when they arrive at L1. These features appeared weaker in imagery on the previous rotation, and wind speeds from the previous rotation were also contaminated by CME arrivals.

There is a further coronal hole 61, which is negative polarity, and Earth may connect to the high speed from this during day 4 (04 March). The timing of this persistent feature is a little uncertain however, due to CME contamination on the previous rotation, and it may arrive after the end of this period.

The coronal holes through Days 1 and 2 are all positive polarity, which are less favoured for a significant geomagnetic response at this time of year. As such, geomagnetic activity is expected to be occasionally Unsettled, with a Slight Chance of isolated Active intervals, declining to mainly Quiet conditions during day 3. If coronal hole 61 does arrive later on day 4, this is more likely to give G1/Minor Storm periods due to the time of year and negative polarity.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	1	1	1	40
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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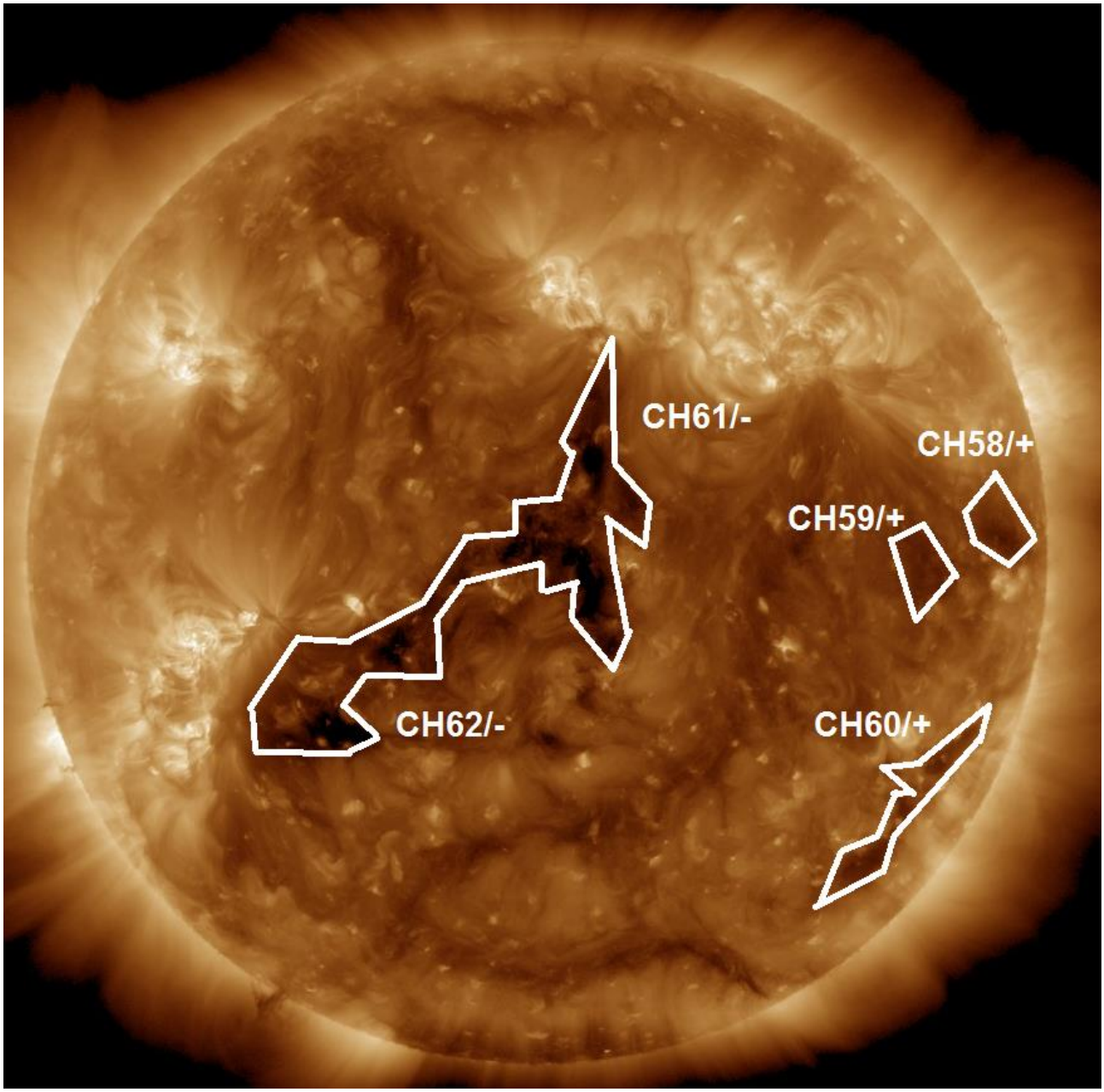
Figure 2: AIA193 imagery from 01/1200UTC showing coronal holes relevant to the forecast period.



Radio Blackouts - X-Ray Flares:

The balance of noteworthy regions on the Earth-facing side is expected to increase in the four-day period, with no spots due to rotate off, and the potential for at least two bright flux regions to arrive over the opposite horizon. Foremost of these appears to be a large region possibly corresponding to Ex-2941 and Ex-2947 in the northern solar hemisphere near 115E, as well as an apparently smaller region perhaps related to Ex-2945 in the south nearer 90E. The contribution from these regions will be as and when they appear on the disc.

Solar activity is expected to remain Low or Very Low, but with a daily Slight Chance of increasing to Moderate levels with isolated M-class flares, the contributory risk roughly evenly partitioned between all the bipolar eastern solar hemisphere groups. Chances may increase later in the four days as sunspots potentially return over the eastern limb.

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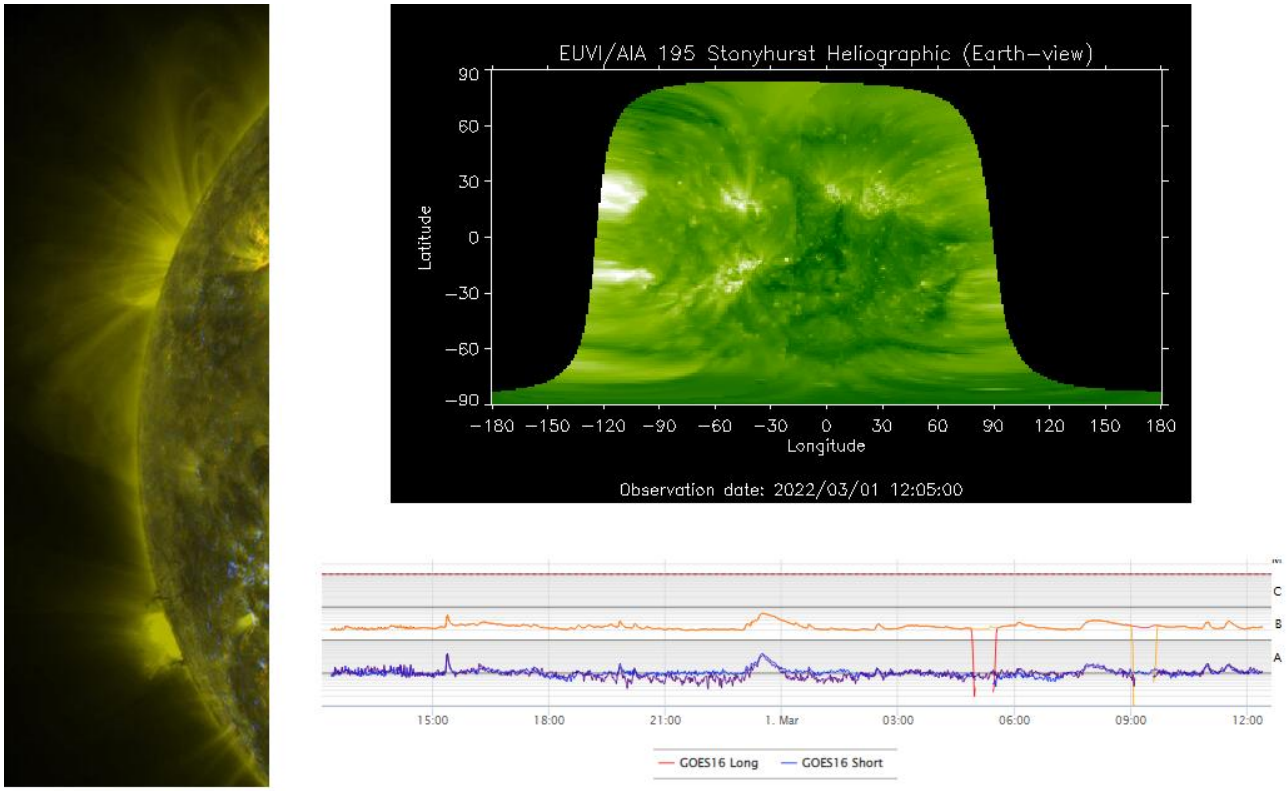
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Clockwise from left: HMIBC and AIA171 composite showing flux detail over eastern limb; EUVI195 cylindrical projection of the sun showing the same upcoming regions; current GOES 16 X-ray flux.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 is at background levels, and expected to remain at this level throughout.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) is currently exhibiting a low trend within Background levels, but ought to respond upwards in the period given incumbent and impending high speed streams.

The relevant four-day period from last rotation suffered from pollution from CMEs, so REFM guidance and persistence in general is expected to offer less of a steer than would usually be the case, meaning that confidence is lower than usual.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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